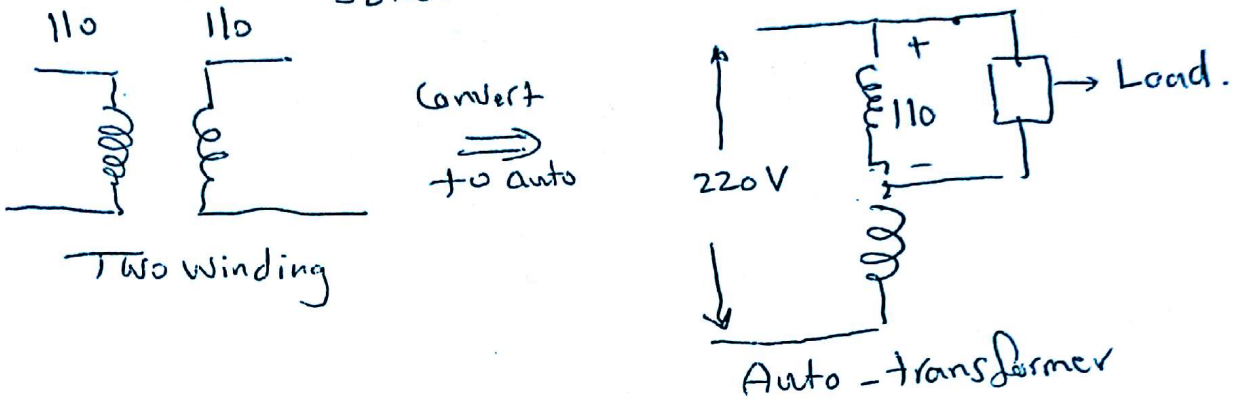
Tutorial #4
EG352

Q A 5 KVA, 110/110 single phase transformer has a full load efficiency of 93.75%. and iron losses of 50W the transformer is now connected as an autotransformer to 220V supply. If it delivers a 5KVA load at 0.75 PF to 110Volt Circuit, Calculate the current drawn by the high voltage side.

Solution-



As Two Winding transformer

$$\eta = 0.9375 = \frac{0.75 \times 5000}{(0.75 \times 5000) + 50 + Cu_{losses}}$$

$Cu_{losses} = 200$ Watt

As Autotransformer

$Cu_{losses} = \frac{200}{4} = 50$ Watt.

losses $\propto I^2$.

input power (P) = 5000 + 100 = 5100 watt

input Power (S) = $5100 / 0.75 = 6800$ VA.

Current in H.V side = $\frac{6800}{220} = 30.9$ A.

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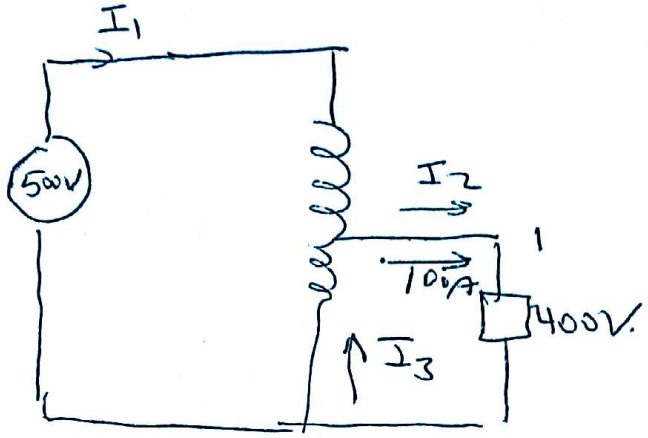
7) The primary and secondary voltages of an auto-transformer are 500V and 400V respectively.

a) Find the current distribution in the winding when the secondary current is 100A.

b) Calculate the economy of Cu in the particular case.



$$a = \frac{400}{500} = 0.8$$

$$I_1 = a I_2 = 0.8 \times 100 = 80\,A.$$

$$I_3 = 100 - 80 = 20A.$$

$$\text{Saving} = a W_0 = 0.8\, W_0.$$

Percentage of saving = 80%

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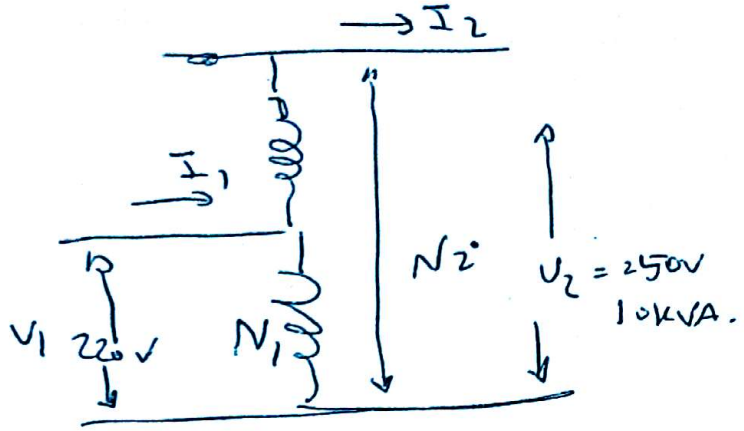
An auto transformer is required to step-up a voltage from 200V to 250V. The total number of coil turns on the transformer main winding is 2000. Determine the position of the primary tapping point, the primary and secondary currents when the output is rated at 10kVA and the economy of copper saved.



$$\frac{N_1}{N_2} = \frac{V_1}{V_2} \Rightarrow N_1 = \frac{N_2 \times V_1}{V_2} = \frac{2000 \times 220}{250} = 1760 \text{ turns.}$$

$$I_2 = \frac{VA}{V_2} = \frac{10000}{250} = 40\,A.$$

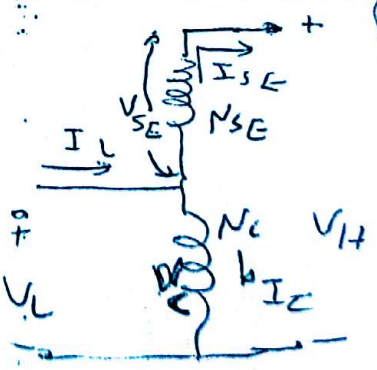
$$S_1 = S_2 = V_1 I_1 = V_2 I_2 \Rightarrow I_1 = \frac{V_2 I_2}{V_1} = \frac{250 \times 40}{220} = 45.4\,A.$$

$$\text{economy} = \frac{220}{250} \times 100 = 88\%$$

$$\frac{V_C}{V_{SE}} = \frac{N}{N_{SE}}, \quad N_C I_C = N_{SE} I_{SE}$$

$$\frac{V_L}{V_H} = \frac{N_C}{N_C + N_{SE}}, \quad \frac{I_L}{I_H} = \frac{N_C + N_{SE}}{N_C}$$

$$\frac{S_{I_o}}{S_W} = \frac{N_{SE} + N_C}{N_{SE}}$$



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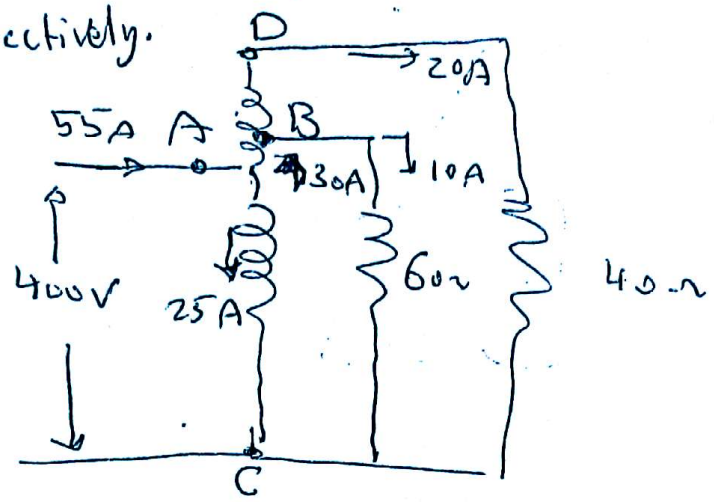
4) An Auto transformer has a coil with total number of $N_{CD} = 200$ between terminals C and D. It has got one tapping at A such that $N_{AC} = 100$ and another tapping at B such that $N_{BA} = 50$. Calculate currents in various parts of the circuit and show their directions when 400V. supply is connected across AC and two resistive loads of 6Ω & 4Ω are connected across BC and DC respectively.



$V_{AC} = 400$ Volt,

$N_{AC} = 100$, Voltage/turn $= \frac{400}{100} = 4$.

Voltage across 4Ω $= N_{DC} \times$ Voltage/turn $= 200 \times 4 = 800$ Volt.

$I_{4\Omega} = \frac{800}{400} = 20$A.

Voltage across 6Ω $= N_{BC} \times$ Voltage/turn $= 150 \times 4 = 600$ Volt.

$I_{6\Omega} = \frac{600}{60} = 10$A.

Total output KVA $= (600 \times 10 + 800 \times 20)$ VA $= 22000$ VA $= 22$ KVA.

$I_{supply} = \frac{22000}{400} = 55$A.

Using KCL.

$I_{BD} = 20$A, $I_{AB} = 20 + 10 = 30$A, $I_{AC} = 55 - 30 = 25$A.

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A single phase transformer 20KVA, 8000/240 Volt, 60Hz to be connected as an auto transformer to supply a load at 8000V, from a 8240V supply. (P_{iron} = 400) & P_{cu} = 240W

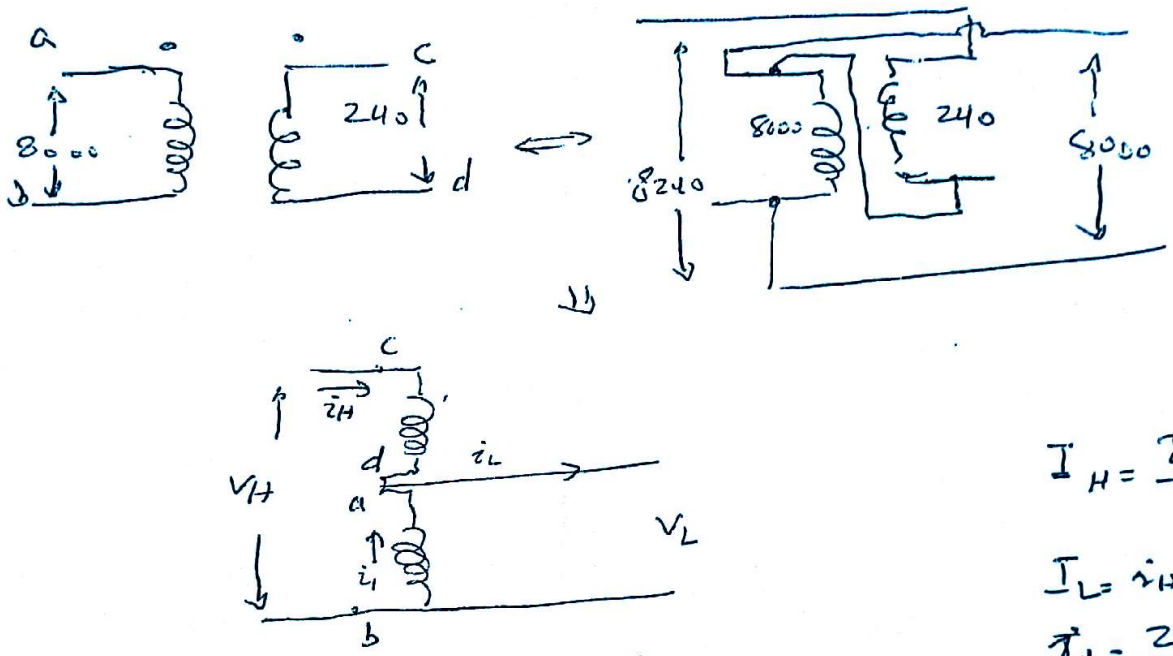
find (a) Draw the connection of the auto-transformer.

(b) The rating of the auto transformer.

(c) The efficiency of the auto-transformer at its rated load 0.8 pf.

(d) The efficiency of the auto-transformer at half its rated load 0.8 pf.

(a) Solution.



$$I_H = \frac{20000}{240} = 83.3$$

$$I_L = i_H + i_1$$

$$i_1 = \frac{20000}{8000} = 2.5 \text{ F}$$

$$\therefore I_L = 2.5 + 83.3 =$$

$$I_L = 85.8 \text{ A}$$

(b) The rating of auto-transformer is

$$S = V_H i_H = V_L i_L$$

$$S = V_H I_H = 8240 \times 83.3 = 686.39 \text{ KVA}$$

$$S = V_L I_L = 8000 \times (85.8) = 686.39 \text{ KVA}$$

(c) The losses within auto-transformer are equal to the losses occuring within two winding transformer.

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$$\therefore \eta_{at\ n=1} = \frac{n S\ pf}{n S \times pf + P_o + n^2 P_{sc}} \times 100 = \frac{1 \times 686.4 \times 0.8}{(1 \times 686.4 \times 0.8) + 0.4 + 24}$$

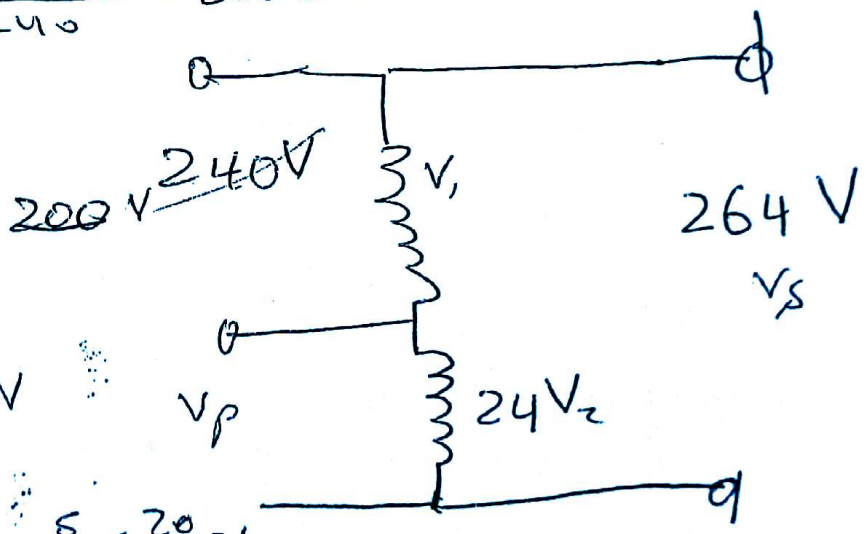
$$\eta_{at\ n=1} = 99.88\%$$

$$\eta_{at\ n=0.5} = \frac{0.5 \times 686.4 \times 0.8}{(0.5 \times 686.8 \times 0.8) + 0.4 + (0.5)^2 \times 0.24} = 99.8\%$$

) A 20 KVA 240/24 volt single phase transformer is to be connected so as to form a step-up auto transformer. A primary voltage of 200 Volt is applies to the auto transformer. that is the secondary voltage of the transformer. that is the maximum volt-ampere rating in this mode? alculate the rating advantages of this auto transformer connection ver the transformer's rating in conventional 240V/24V operation.

) $V_{1+} = V_2 \cdot \frac{N_{SC} + N_C}{N_C} = \frac{24 + 240}{240} \cdot 200 = 220V.$

ec method.



$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$V_2 = \frac{200 \times 24}{240} = 20V$

$V_s = 200 + 20V = 220V$

$I_{out} = 220 \times (1) \longrightarrow \frac{S}{V} = \frac{20}{2} = 1$

$= 220\ VA$

) The advantage $\frac{S_{IO}}{S_W} = \frac{220}{20} = 11.$

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A 100VA (120/12)V transformer is to be connected so as form a step up autotransformer. A primary voltage of 120 V is applied to the auto transformer.

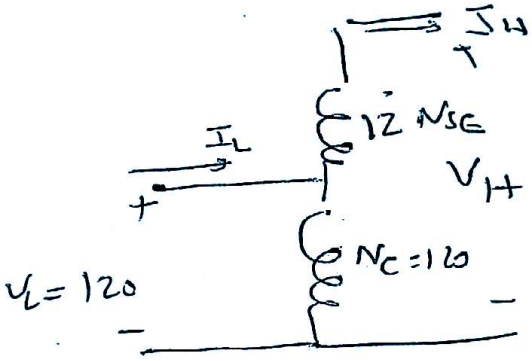
a) What is the secondary voltage of the transformer?

b) What is its maximum voltampere rating in this mode of operation.

c) Calculate the rating advantage of this ~~transformer~~ autotransformer connection over the transformer's rating in conventional (120/12)V operation?

Solution

To accomplish a step up transformer with a 120V primary the ratio of the turns on the common winding N_C to the turns on the series winding N_{SE} in this transformer must be (120/12) or (10/1)



a) This transformer is being used as a step up transformer.

The secondary voltage V_H

$$V_H = V_L \cdot \frac{N_{SE}+N_C}{N_C} = \frac{12+120}{120} \cdot 120 = 132 \text{ Volts}$$

b) The maximum series winding current is

$$I_{SE\,max} = \frac{S_{max}}{V_{SE}} = \frac{100VA}{12V} = 8.33A.$$

$\therefore V_S = V_H = 132V.$ (Secondary)

$\therefore S_{out} = V_S I_S = V_H I_H = 132 \times 8.33 = 1100VA = S_{in}$

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